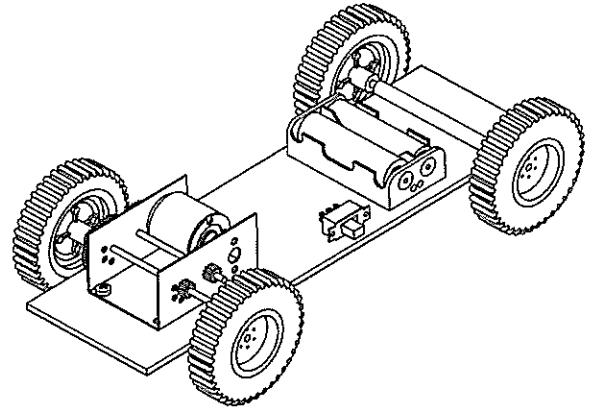


# SIMPLE VEHICLE (NO STEERING)

## DESCRIPTION

This project requires the student to design and build a *SIMPLE VEHICLE*. This is the most basic vehicle possible, and is suitable to introduce students to Technology and Electrical components. After completion of the vehicle, it can be used for a variety of experiments (physics or otherwise) or even paired with another vehicle for racing and performance tests.



This is a basic four wheeled vehicle, with both front and rear wheels on fixed axles. This vehicle:

- is capable of forward and reverse motion (the direction of travel being controlled by a two-way switch)
- has a choice of gearbox ratios (at the construction stage).

## INVESTIGATION / EVALUATION

The Design component is affected by the planned usage of the vehicle. This will have an affect on the gearing selected, switch location, vehicle size – especially if performance testing or vehicle to vehicle comparisons are the intended usage.

HINT: The *DRAGSTER* teaching unit has a comprehensive section on gearing and performance, speed and acceleration, and other ideas on ideas for evaluations and testing – see that on our website.

- Evaluate the suitability of various materials for the platform: eg: Aluminium, PVC and Perspex.
- The gearbox has a choice of 3 ratios – one must be selected. The vehicle's acceleration and speed are affected by the choice. Note: the higher the gear ratio, the lower the vehicle's speed.
- Investigate the effects of gearing on speed and acceleration.
- Investigate how gears work and explain Gear ratios, explain the motion of gears in a gear train.
- Give examples of different types of gear systems and where they are used.
- Set up a chart of the different gear ratios available using the various gear combinations. Record varying acceleration rates and top speeds for each combination.

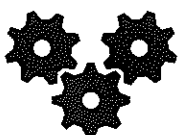
## DESIGN STAGES.

(a) The major aspects of this project are the vehicle's design, construction and assembly. The design stage is crucial, as the location of all components is worked out. This can be done by laying all of the components on a sheet of graph paper. The layout affects the size and shape of the vehicle's chassis, as well as the ease of assembly.

(b) To carry out this project, a student must:

- decide on the desired Gearbox ratio
- define the locations of components on the platform
- design and fabricate the vehicle platform (and body?)
- assemble the vehicle

(c) The choice of the gearbox ratio will be determined by what the vehicle will be used for. The decision must be made prior to starting assembly. The *MULTI-RATIO GEARBOX* kit provides a choice of 3 gear ratios. Before starting, the desired ratio must be chosen, as this defines the parts to be used, and the assembly procedure. Refer section 3 for the drawings showing the 3 options to choose from.



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*SIMPLE VEHICLE* teaching unit June 2008

The choice of ratios available at the „Output” shaft are:

- Single reduction (shaft A) = 1:5
- Double reduction (shaft B) = 1:25
- Triple reduction (shaft A) = 1:125

The motor, under load, turns at approximately these speeds.

- with 3 Volts (ie. 2xAA batteries) 6,500 RPM
- with 6 Volts (ie. 4xAA batteries) 12,600 RPM

(d) One suggestion is to mount the two-way switch and battery holder in a small box. This control unit is hand held, and is connected by a length of wire to the vehicle. The suggested length of the wire is 1 to 2 metres. A guide “pole” is recommended to keep the control wires away from the rear wheels.

## 1. COMPONENTS REQUIRED

### 1.1 COMPONENTS SUPPLIED

1.1.1 The following parts are supplied in the kit:

- |                                  |   |
|----------------------------------|---|
| 1 x Two way (Big) sliding switch | 1 x 2.5 mm. dia x 100-150 mm long steel rod |
| 1 x Battery holder – 2AA         | 1 x 125 mm Plastic Tube                     |
| 4 x 52 mm dia. Wheels            | 2 x Self-tapping screws 3mm x 4mm long      |

The following parts are supplied for the *MULTI-RATIO GEARBOX*:

- |                                     |                                   |
|-------------------------------------|-----------------------------------|
| 1x Multi-ratio Gearbox case         | 2x 12T Pinions 2.4 hole           |
| 1x 4.5V Electric Motor (round)      | 1x 10T Pinion 1.9 hole            |
| 2x 2.5 dia x 120-150 long steel rod | 1x 3mm inner dia 1.0 thick Washer |
| 2x 50T Spur gears (white)           | 2x M2.6x 4 self-tapping Screws    |
| 1x 50T Spur gear (yellow)           |                                   |

### 1.2 ADDITIONAL REQUIREMENTS

1.2.1 Batteries are required and available from us, but need to be ordered separately. If you choose to use 6V power, we also have 4AA battery holders available.

1.2.2 The following material and parts are to be supplied by the student / designer: Material for the chassis; two core wire; suitable adhesive (eg hot glue gun); everything else!

## 2. PLATFORM

2.1 CHOICE OF MATERIAL: Material for the platform can be any material stiff enough to support all the components - 3-ply, Balsa, PVC and Acrylic are some options.

2.2 LAYOUT: The student should make an accurate, to scale, drawing locating all the components: wheels and gearbox / motor before commencing construction.

2.3 BODY (OPTIONAL): In addition to the basic platform, a body may be constructed for this vehicle. It might be fabricated from plastic sheet, vacuum formed or carved from styrene.

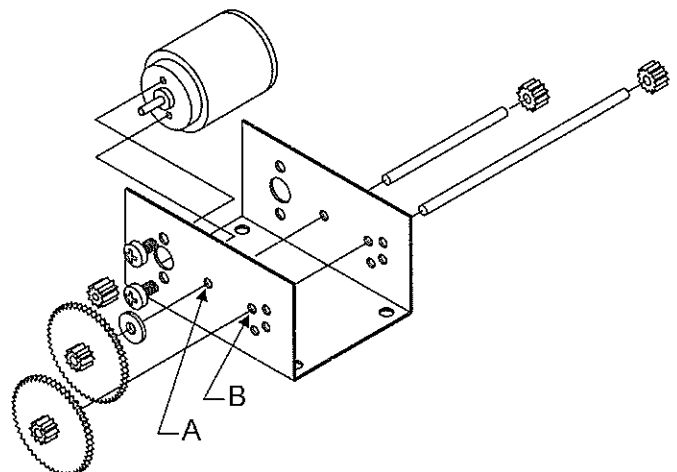
## 3. THE MULTI RATIO GEARBOX

HINT: Before starting assembly, the following must be done (based on the intended use of the gearbox):

- select the desired gearbox ratio
- define the length of the axle shaft, and cut (and de-burr) the steel rod to that length.

### 3.1 ASSEMBLING THE GEARBOX

GENERAL: the white gears are press fit on to the shafts and have either 2.4 or 1.9 holes. The yellow spur gear is free wheeling on the shaft and has a 2.6 diameter hole. The 12T pinions are used as locators.



3.1.1 Assemble the steel rod, and all the gears, to the gearcase - as shown in the appropriate drawing. The gears can be assembled onto the shaft/s with a help of small hammer.

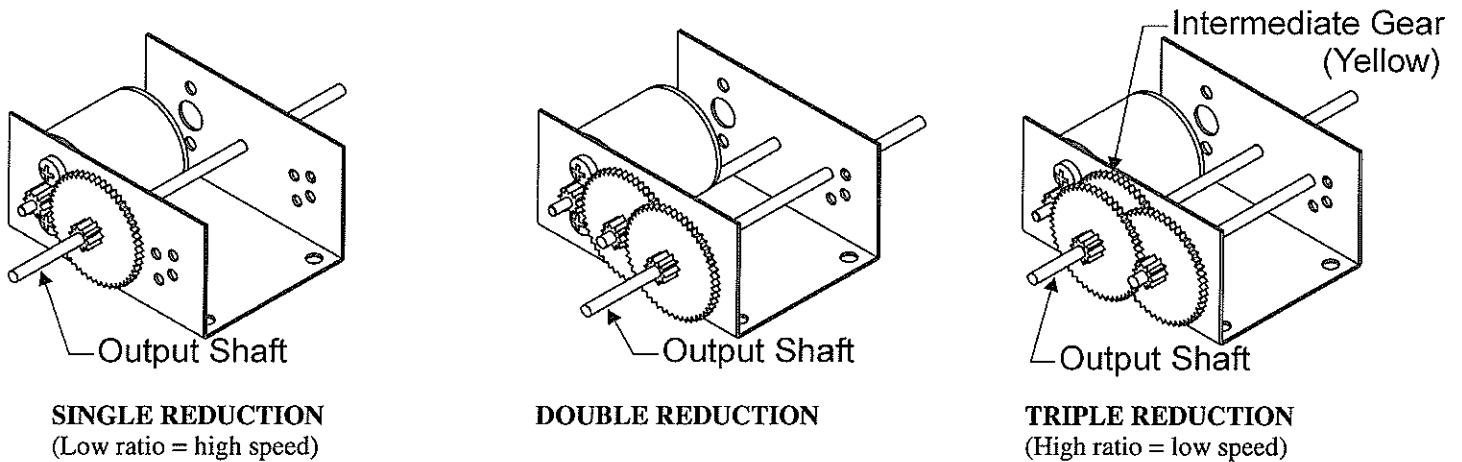
3.1.2 Press the 10T pinion onto the motor shaft.

Hint: Place the gear on the bench, insert the motor shaft into the worm gear's hole and gently tap the end of the shaft (where it exits the motor) with a small hammer. Stop when the worm gear is 3mm from the motor's body.

**WARNING:** Don't just push the motor down by hand as this can push the motor armature out of its bearings and jam the motor.

3.1.3. Secure the motor to the gearbox case using the two self-tapping screws.

3.1.4. Solder a suitable length of wire to each of the motor's terminals.

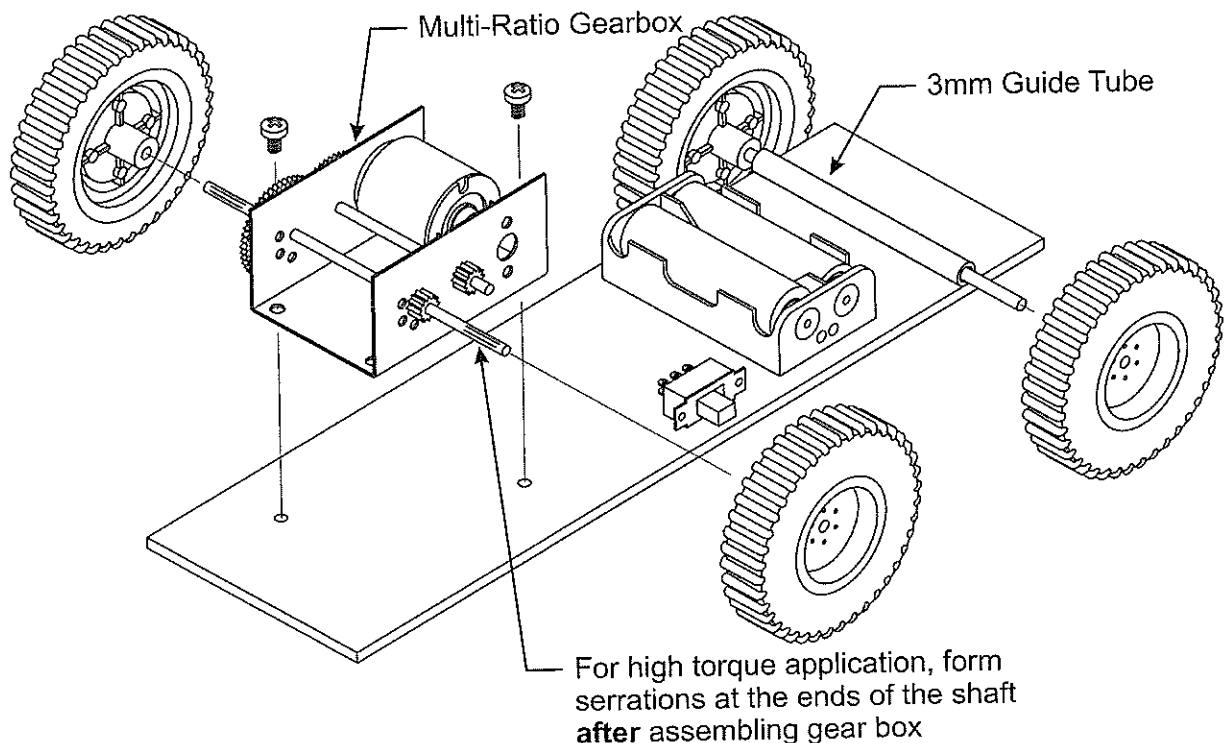


### 3.2 MOUNTING THE GEARBOX:

To hold the gearbox in place, drill two, 2.3 mm holes diagonally opposite each other in the chassis, to match the holes in the gearcase's corners. The self-tapping screws should be inserted from the top of the gearcase and secured to the chassis.

## 4. FRONT WHEELS

Note: if a high torque application is required, serrations should be formed along the ends of the driven rear axle (the serrations can be formed using eg. a cold chisel, but they should be shallow).



The plastic tube is for use as an axle guide, and is glued to the chassis. This axle / guide tube length can be a limiting factor to the width of the vehicle. The tubes should be about 2-3 mm longer than the width of the chassis to which it is glued. This will prevent the wheels rubbing against the chassis, and slowing the vehicle down.

HINT: When hot gluing the tube in place it is a good idea to put one of the long steel rods into the tube. Place a line of hot glue on the chassis where the axle is to be situated. Hold the ends of the steel rod and press the plastic tube down onto the hot glue. This will help in two ways.

- Holding onto the ends of the steel rod projecting at each end of the tubing will help to prevent any hot glue getting on your fingers.
- Holding the steel rod inside the tubing prevents the plastic tubing from bending due to heat from the hot glue.

## **5 WIRING / ELECTRICAL COMPONENTS**

### **5.1 ELECTRIC MOTOR**

5.1.1 The electric motor will work on voltages between 1.5 and 6 volts. This is mounted as part of the Gearbox assembly.

5.1.2 The motor is powered by two 1.5 volt batteries. If the motor is supplied with 3 volts, it will operate at the specified speed, but will spin much faster when using 6 volts.

Note: It is recommended not to increase the power supplied over 6 volts, otherwise the life expectancy of the motor may be significantly reduced.

5.1.3 The motor is non-polarised: i.e. the wires do not need to be connected to a specific terminal. The electric motor should be wired as shown in the "Wiring Schematic".

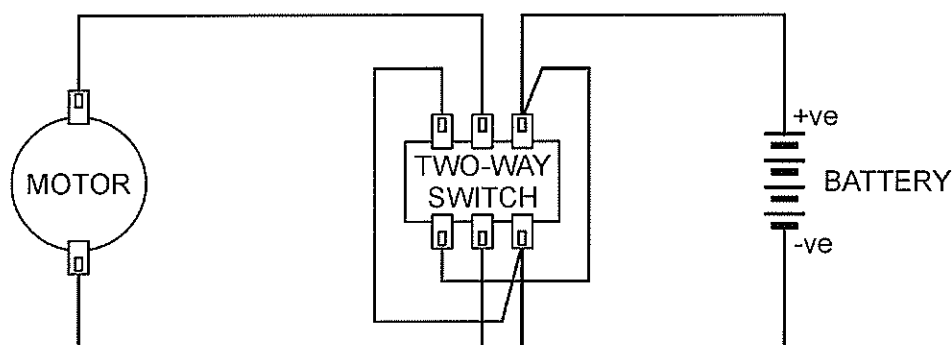
### **5.2 THE TWO-WAY SWITCH**

5.2.1 It is suggested that the two-way switch and battery holder are mounted in a small box. This control unit is hand held, and is connected by a length of wire to the vehicle. The suggested length of the wire is 1 to 2 metres. A guide "pole" is recommended to keep the control wires away from the rear wheels.

5.2.2 The Two-way Switch should be wired as shown in the "Wiring Schematic". This allows forward and reverse motion of the vehicle.

### **5.3 BATTERY HOLDER**

5.3.1 The battery holder supplied is for 3 volt (2 x 'AA').



WIRING SCHEMATIC

That's it - You have successfully built your *SIMPLE VEHICLE* !!! Now to start using it ....